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SPECIFICATION

CMP CONDITIONER

Cross Reference to Prior Application

This is a U.S. national phase application under 35 U.S.C. §371 of International Application No. PCT/JP2005/005926 filed March 29, 2005 and claims the benefit of Japanese Applications No. 2004-106414, filed March 31, 2004 and 2005-035729, filed February 14, 2005. The International Application was published in Japanese on October 13, 2005 as International Publication No. WO 2005/095056 under PCT Article 21(2).

Field of the Invention

The present invention relates to a chemical mechanical polishing (CMP) conditioner used for dressing (toothing) of an abrasive pad of a CMP apparatus for polishing a semiconductor wafer or the like.

Background Art

As such a kind of a CMP conditioner, for example, in Japanese Unexamined Patent Application Publication No. 2001-71269 ("Patent Document 1"), a CMP conditioner in

which a plurality of substantially cylindrical protrusions is formed on an upper surface of a circular-plate-shaped base (base metal) at an interval and a plurality of abrasive grains such as diamond is fixed on the surface of the protrusion by a metal plating phase is suggested. Accordingly, according to such a CMP conditioner, a high polishing pressure can be maintained against the abrasive grains, without entirely bringing the upper surface of the base of the conditioner fixed with the abrasive grains into contact with the pad of a CMP apparatus and thus sharpness can be improved. In addition, a polishing fluid can be held in concave portions between the protrusions and thus dischargeability of chips can be improved.

In Japanese Unexamined Patent Application Publication No. 2002-337050 ("Patent Document 2"), a CMP conditioner in which a plurality of small abrasive grain layer parts protruded in a convex curve shape is arranged on an upper surface of a base at an interval, ring-shaped circumferential abrasive grain layer parts protruded in the same height as the small abrasive grain layer parts are provided on the outer circumference of the small abrasive grain layer parts, and a plurality of abrasive grains are fixed on the surface of the abrasive layer parts by a metal plating phase is suggested. Among them, the circumferential abrasive grain layer parts come in surface contact with a pad such that the surface pressure of the

conditioner is prevented from greatly increasing and a polishing process can be performed by the small abrasive grain layer parts with good sharpness. Accordingly, over-polishing of the pad or fracturing of the abrasive grains is suppressed and thus the good sharpness due to appropriate depth of cut can be ensured.

The outer circumferential side of the circumferential abrasive grain layer part of the base has a convex curve shape or a taper shape of a cut plane R having a slant slower than the sidewall of an inner side and thus the pad can be prevented from being peeled upon start-up of polishing.

Disclosure of the Invention

Problems to be Solved by the Invention

However, in Patent Documents 1 and 2, in order to fix the plurality of abrasive grains on the surface of the protrusion protruded from the upper surface of the base, such as the protrusion of Patent Document 1 or the small abrasive grain layer part and the circumferential abrasive grain layer part of Patent document 2, by the metal plating phase, masking is performed on the upper surface of the base except a rising part which becomes the protrusion or the abrasive grain layer part, and the abrasive grains are then fixed by electroplating. Accordingly, the abrasive

grains are fixed on the protrusion or the abrasive grain layer part over the whole surface. To this end, in the CMP conditioners of Patent Documents 1 and 2, for example, the abrasive grains are also fixed to a cross ridge line between a circular protrusion section for configuring the cylindrical protrusion and the cylindrical outer circumferential wall surface, which rises from the upper surface of the base, of Patent Document 1 or the periphery of a cross ridge line between the ring-shaped (annular) protrusion section for configuring the circumferential abrasive grain layer part and the inner sidewall, which rises from the upper surface of the base, of Patent Document 2.

The cross ridge line between the wall surface which steeply rises from the upper surface of the base, such as circumferential wall surface of the protrusion or the inner sidewall of the circumferential abrasive grain layer part, and the protrusion section which is parallel to the upper surface of the base has a cross angle smaller than that of the cross ridge line between the protrusion section of the circumferential abrasive grain layer part and the convex curve having a slow slant of the outer circumference thereof of Patent document 2, that is, is a pin angle state. Accordingly, when the abrasive grains are fixed on the cross ridge line or when the abrasive grains are fixed to be protruded from the cross ridge line even on the

protrusion section or the wall surface, the protruded abrasive grains cannot be supported by the base through the metal plating phase. To this end, these abrasive grains may be unstably fixed and, when the unstable abrasive grains are detached when dressing the pad, the polished semiconductor wafer may be scratched.

When the abrasive grains are fixed over the whole surface of the protrusion and, more particularly, the cross ridge line between the protrusion section and the wall surface, the abrasive grains are positioned on the periphery of the protrusion section, which is in contact with the pad at the time of dressing. Accordingly, it is difficult to sufficiently ensure a space for holding the polishing fluid between the protrusion section surrounding the abrasive grains positioned in the periphery and the pad at the time of dressing. However, the abrasive grains positioned in the periphery of the protrusion section of the protrusion are cut into the surface of the pad earlier than the other abrasive grains fixed to the protrusion section to perform the dressing. Accordingly, when the polishing fluid is not sufficiently held in the vicinity of such abrasive grains, abrasion of the abrasive grains are significantly accelerated, a polishing rate of the pad is reduced, and thus polishing efficiency of the semiconductor wafer using the CMP apparatus deteriorates or the life span of the conditioner is reduced.

The present invention is made under such a background, and an object of the present invention is to provide a CMP conditioner which can stably fix abrasive grains to prevent a scratch from being generated due to detachment of the abrasive grains and surely ensure a space for holding polishing fluid between a protrusion section surrounding the abrasive grains and a pad at the time of dressing in a CMP conditioner in which the abrasive grains are fixed to a protrusion protruded on an upper surface of a base.

Means for Solving the Problems

In order to solve the problems and to accomplish such an object, there is provided a CMP conditioner in which a protrusion is protruded from an upper surface of a base which rotates around an axis line and a plurality of abrasive grains is fixed to the protrusion, wherein the abrasive grains are fixed such that the abrasive grains are not protruded from a virtual extending surface which extends from the periphery of a protrusion section, which faces a protrusion direction of the protrusion, along the axis line.

Effects of the Invention

In the CMP conditioner described above, since the plurality of abrasive grains fixed to the protrusion section of the protrusion protruded from the upper surface of the base is not protruded from the virtual extending

surface of the periphery of the protrusion section, although some abrasive grains is positioned on the periphery, the protrusion section of the protrusion necessarily exists at the opposite side, that is, the base side, of the protrusion direction of the abrasive grains, and thus such abrasive grains can be surely and stably supported by the protrusion section and strongly fixed. Since the plurality of abrasive grains is fixed such that the protrusion section is disposed at the base side of the abrasive grains, it is possible to ensure a space for sufficiently supporting the polishing fluid between the pad and the protrusion section at the time of dressing. Accordingly, according to the above-described CMP conditioner, it is possible to surely prevent the abrasive grains from being detached at the time of dressing to prevent a semiconductor wafer from being scratched, to suppress the abrasion of the abrasive grains which are located at the periphery and precedingly cut into the pad to stably maintain the polishing rate of the pad for a long period, and to efficiently polish the semiconductor wafer and increase the life span of the conditioner.

When the plurality of abrasive grains is protruded from the virtual extending surface, some abrasive grain may be fixed close to the virtual extending surface. When the plurality of abrasive grains is fixed on the protrusion section in a region separated from the virtual extending

surface by at least a fourth of the average grain diameter of the abrasive grains, the stability of the abrasive grains can be more improved, the detachment of the abrasive grains can be surely prevented, and a space surrounding the abrasive grains can be more ensured to ensure the more sufficient polishing fluid. However, when the abrasive grains are fixed at a deep position of the protrusion section or a single abrasive grain is fixed to the central portion of the protrusion section, the periphery of the protrusion section is brought into contact with the pad to cause abrasion or the polishing pressure due to the abrasive grain may excessively increase. Accordingly, it is preferable that the plurality of abrasive grains is fixed to the protrusion section, and, among them, the abrasive grains fixed on the periphery of the protrusion section are fixed in a region from the virtual extending surface to a position separated from the virtual extending surface by three times the average grain diameter of the abrasive grains.

For example, like the substantially cylindrical protrusion of Patent Document 1, when the protrusion is formed to be protruded from the upper surface of the base in the cylindrical shape, and has the protrusion section perpendicular to the axis line and an outer circumferential wall surface which rises from the upper surface of the base toward the protrusion section around the protrusion section,

it is preferable that the abrasive grains are fixed such that the abrasive grains are not protruded outwardly from the virtual extending surface, which extends from an outer periphery of the protrusion section of the protrusion. For example, like the circumferential abrasive grain layer part of Patent Document 2, when the protrusion is formed in a substantially annular shape at an outer circumference of the upper surface of the base and has the protrusion section having a substantially annular shape and perpendicular to the axis line and an inner circumferential wall surface which rises from the upper surface of the base toward the protrusion section at an inner circumference of the upper surface of the base, it is preferable that the abrasive grains are fixed such that the abrasive grains are not protruded from the virtual extending surface, which extends from an inner periphery of the protrusion section of the protrusion, to the inside of the upper surface of the base. On the upper surface of the base, by coating at least the protrusion section of the protrusion with a tetrafluoride-based organic compound, it is possible to surely maintain the pad polishing rate although slurry having high corrosive properties or adhesion is used as the polishing fluid.

Brief Description of the Drawings

Fig. 1 is a plan view of a CMP conditioner according

to an embodiment of the present invention when viewed from a side facing an upper surface 2 of a base 1 along an axis line O.

Fig. 2 is a partial enlarged cross-sectional view of the embodiment shown in Fig. 1.

Fig. 3 is a partial enlarged cross-sectional view when the embodiment shown in Fig. 1 is manufactured by a photoresist method.

Fig. 4 is a partial enlarged cross-sectional view when the embodiment shown in Fig. 1 is manufactured by a template method.

Fig. 5 is a cross-sectional view of the CMP conditioner in which abrasive grains 5 are fixed to be protruded from a virtual extending surface P.

Best Mode for Carrying out the Invention

Figs. 1 and 2 show a CMP conditioner according to an embodiment of the present invention. In the present embodiment, a base 1 is formed of a metal material such as stainless steel and has a circular plate shape, as shown in Fig. 1. At the time of dressing, an circular upper surface 2 advances to a pad of a CMP apparatus and rotates around a central axis line O of the base 1 such that the axis line O reciprocally oscillates in a diameter direction of the pad. A plurality of cylindrical protrusions 3 protruded from the upper surface 2 is formed on an inner circumference of the

upper surface 2 at a predetermined interval, an annular protrusion 4 protruded from the upper surface 2 is formed on an outer circumference of the upper surface 2, and a plurality of abrasive grains 5 is fixed to the protrusions 3 and 4, respectively. A portion of the upper surface 2 except the protrusions 3 and 4 is a flat surface perpendicular to the axis line O.

Among the protrusions 3 and 4, the cylindrical protrusion 3 formed on the inner circumference of the upper surface 2 is protruded in a cylindrical shape (circular plate shape) having a center line parallel to the axis line O. That is, the protrusion 3 includes a flat protrusion section 3A having a circular shape and perpendicular to the axis line O of the base 1, and a cylindrical outer circumferential wall surface 3B which rises from the upper surface 2 toward the protrusion section 3A around the protrusion section 3A and is integrally formed with the base 1. Accordingly, in the present embodiment, the outer circumferential wall surface 3B vertically rises from the flat upper surface 2 and the protrusion section 3A vertically crosses the outer circumferential wall surface 3B to form a cylindrical cross ridge line. The cross ridge line is a periphery (outer periphery) 3C of the protrusion section 3A of the protrusion 3. The plurality of protrusions 3 has the same shape and the same size, that is, the same outer diameter and the same protrusion height from

the upper surface 2 to the protrusion section 3A.

The protrusion 4 formed on the outer circumference of the upper surface 2 is integrally formed with the base 1 to be protruded from the upper surface 2 in the direction of the axis line O and has an annular shape centered on the axis line O and is separated from the protrusion 3 when viewed in the direction of the axis line O. The protrusion 4 includes a flat protrusion section 4A having an annular shape and perpendicular to the axis line O and a cylindrical inner circumferential wall surface 4B which rises from the upper surface 2 toward the protrusion section 4A at the inner circumference of the protrusion section 4A of the upper surface 2. The inner circumferential wall surface 4B vertically rises on the upper surface 2 to vertically cross the protrusion section 4A, similar to the outer circumferential wall surface 3B of the protrusion 3, and thus the cross ridge line thereof has a cylindrical shape centered on the axis line O and is a periphery (inner periphery) 4C of the protrusion section 4A of the protrusion 4. The height of the protrusion section 4A protruded from the upper surface 2 is identical to the protrusion height of the protrusion 3. An outer circumferential portion of the protrusion section 4A has a slope surface 4D which gradually retreats toward the outer circumference at an angle smaller than the rising angle of the inner circumferential wall surface 4B.

The abrasive grains 5 fixed to the protrusions 3 and 4 are, for example, diamond-like abrasive grains having an average grain diameter of about 160 μm. The plurality of abrasive grains 5 is fixed to the protrusion 3 and the protrusion 4 through a metal plating phase 6 such as a Ni by electrodeposition. A portion corresponding to about 30% of the average grain diameter of the abrasive grains 5 is protruded from the metal plating phase 6 and the rest thereof is embedded in the metal plating phase 6.

The plurality of abrasive grains 5 fixed to the protrusions 3 and 4 is not protruded from a virtual extending surface P which extends from the peripheries 3C and 4C of the protrusion sections 3A and 4A in the direction of the axis line O, on the protrusion sections 3A and 4A of the protrusions 3 and 4, as shown in Fig. 2. That is, when viewed from a side facing the upper surface 2 of the base 1 along the axis line O in a plan view, on the protrusion sections 3A and 4A, the abrasive grains 5 are fixed to be positioned at the inside of the peripheries 3C and 4C of the protrusion sections 3A and 4A, without overlapping with the peripheries 3C and 4C of the protrusion sections 3A and 4A.

Since the cylindrical protrusion 3 protruded from the upper surface 2 has a central line parallel to the axis line O and the cross ridge line between the outer circumferential wall surface 3B which extends in parallel

to the central line and the protrusion section 3A perpendicular to the axis line O is the periphery 3C, the virtual extending surface P becomes an extending surface of the outer circumferential wall surface 3B and the abrasive grain 5 is not protruded from the virtual extending surface P outwardly. In the annular protrusion 4 protruded on the outer circumference of the upper surface 2, since the cross ridge line between the protrusion section 4A perpendicular to the axis line O and the inner circumferential wall surface 4B perpendicular to the protrusion section 4A, that is, parallel to the axis line O, is the periphery 4C of the protrusion section 4B, the virtual extending surface P becomes the extending surface of the inner circumferential wall surface 4B and the abrasive grain 5 is not protruded from the virtual extending line P inwardly. In the present embodiment, while the plurality of abrasive grains 5 is fixed on the slope surface 4D located at the outer circumference of the protrusion section 4A by the metal plating phase 6 continuous from the protrusion section 4A, the abrasive grains 5 are not fixed on the outer circumferential wall surface 3B of the protrusion 3, the inner circumferential wall surface 4B of the protrusion 4, the upper surface 2 located between the protrusions 3 and 4, except the protrusion sections 3A and 4A and the slope surface 4D.

In the present embodiment, the abrasive grains 5 are

not protruded from the virtual extending surfaces P of the protrusion sections 3A and 4A of the protrusions 3 and 4 and are fixed in a region L separated from the virtual extending surfaces P by a fourth of the average grain diameter of the grain particle 5 on the protrusion section 3A and 4A, that is, all of the plurality of the abrasive grains 5 fixed on the protrusions 3 and 4 are disposed in the region L. In addition, the abrasive grains 5 closest to the peripheries 3C and 4C of the protrusion sections 3A and 4A are located in a region M from the virtual extending surface P to a position separated from the virtual extending surface P by three times the average grain diameter of the abrasive grain 5. Accordingly, in the present embodiment, a non-fixture region N, in which the abrasive grain 5 is not fixed, is formed from the peripheries 3C and 4C to a position separated from the peripheries 3C and 4C by at least a fourth of the average grain diameter of the abrasive grain 5 in the peripheries 3C and 4C of the protrusion sections 3A and 4A, and at least one of the plurality of abrasive grains 5 is fixed in the region M except the non-fixture region N, that is, a region from a position separated from the peripheries 3C and 4C by a fourth of the average grain diameter of the grain 5 to a position separated from the peripheries 3C and 3D by 3 times the average grain diameter of the grain 5.

In order to fix the abrasive grains 5 on the

protrusion sections 3A and 4A of the protrusions 3 and 4 such that the abrasive grains are not protruded from the virtual extending surface P and form the non-fixture regions N at the peripheries 3C and 4C of the protrusion section 3A and 4A as in the present embodiment, the abrasive grains 5 are fixed only in the region L by the metal plating phase 6 using a photoresist method shown in Fig. 3. In the photoresist method, among the upper surface 2 of the base 1 on which the protrusions 3 and 4 are formed, a portion in which the abrasive grains 5 are not fixed, including the non-fixture region N, is covered by a photoresist film 7, as shown in Fig. 3A, the base 1 is immersed in a plating solution to form an underlying plating layer 6A on the region L exposed from the film 7, as shown in Fig. 3B, and the base 1 is immersed in a plating solution in which the abrasive grains 5 are dispersed to perform electrodeposition. Accordingly, as shown in Fig. 3C, the abrasive grains 5 are temporarily fixed by a first metal plating phase 6B.

Subsequently, as shown in Fig. 3D, the photoresist film 7 is peeled from the inner and outer circumferential wall surfaces 3B and 4B of the protrusions 3 and 4 and the upper surface 2 located between the protrusions 3 and 4, and the base 1 is immersed in a plating solution, in which the abrasive grains 5 are not dispersed, to form a second metal plating phase 6C such that the abrasive grains 5 are

protruded by the above-described protrusion height. Accordingly, it is possible to obtain the CMP conditioner according to the present embodiment, in which the abrasive grains 5 are fixed only in the region L exposed from the photoresist film 7 by the metal plating phase 6 including the underlying plating layer 6A and the first and second metal plating phases 6B and 6C. In this case, in the non-fixture region N, since the second metal plating phase 6c is formed in a place where the underlying plating layer 6A or the first metal plating phase 6B are not formed, the metal plating phase 6 slightly becomes thinner at the peripheries 3C and 4C, as shown in Fig. 2 or Fig. 3E.

Instead of the photoresist method, the abrasive grains may be fixed only in the region L by a template method, as shown in Fig. 4.

In the template method, as shown in Fig. 4, a template 8 including an upper plate 8A in which the region L of the upper surface 2 of the base 1, in which the abrasive grains 5 will be fixed, is opened, and a lower plate 8B having an outer diameter portion which can be fitted into the inner circumferential wall surface 4B of the annular protrusion 4 and a hole which can receive the outer circumferential wall surface 3B of the cylindrical protrusion 3 is used. The upper plate 8A and the lower plate 8B are fixed to each other by spot welding or the like. The template 8 is attached to the upper surface 2 of

the base 1 such that the outer diameter portion of the lower plate 8B is fitted into the inner circumferential wall surface 4B of the protrusion 4, the outer circumferential wall surface 3B of the protrusion 3 is received in the hole, and overhang portions 8C of the upper plate 8A protruded from the outer diameter portion and the inner circumference of the hole of the lower plate 8B are closely fixed to the protrusion sections 3A and 4A of the protrusions 3 and 4.

In this state, the abrasive grains 5 are temporarily fixed such that the underlying plating layer 6A and the first metal plating phase 6B are not formed and the abrasive grains 5 are not temporarily fixed on portions of the protrusion sections 3A and 4A, to which the overhang portions 8C are closely fixed, similar to Figs. 3A to 3C. Subsequently, the template 8 is detached and the second metal plating phase 6C is then formed similar to Figs. 3D and 3E. Accordingly, the portions to which the overhang portions 8C are closely fixed become the non-fixture region N and thus the CMP conditioner of the present embodiment in which the abrasive grains 5 are fixed by the metal plating phase 6 in the region L separated from the peripheries 3C and 4C can be obtained. In the template method, it is preferable that the inner circumferential wall surface 4B of the annular protrusion 4 of the base 1 is subjected to a machining process such as a lathe machining process such

that high positioning precision is obtained when the outer diameter portion of the lower plate 8B is fitted into the inner circumferential wall surface 4B and the template 8 is attached to the upper surface 2.

In the upper surface 2 of the base 1 on which the abrasive grains 5 are fixed, for example, tetrafluoride-based organic compound such as polytetrafluoroethylene (PTFE), tetrafluoroethylene-hexafluoro-propylene copolymer (FEP), tetrafluoroethylene-perfluoroalkylvinyleter copolymer (PFA), or tetrafluoroethylene-ethylene copolymer (ETFE) is coated on at least the protrusion sections 3A and 4A of the protrusions 3 and 4. Similar to the protrusion sections 3A and 4A, the tetrafluoride-based organic compound may be coated on the whole upper surface 2 of the base 1 including the slope surface 4D on which the abrasive grains 5 are fixed, and the outer circumferential wall surface 3B of the protrusion 3 or the inner circumferential wall surface 4B of the protrusion 4 and the upper surface 2 located between the protrusions 3 and 4, on which the abrasive grains 5 are not fixed. The tetrafluoride-based organic compound is formed by immersing the base 1 on which the abrasive grains 5 are fixed by the metal plating phase 6 in a solution in which the tetrafluoride-based organic compound is dispersed to perform an electrodeposition coating process.

For example, in the CMP conditioner manufactured by

the above-described method, since the plurality of abrasive grains 5 fixed to the cylindrical protrusion 3 protruded on the inner circumference of the upper surface 2 of the base 1 or the annular protrusion 4 formed on the outer circumference of the upper surface 2 are not protruded from the virtual extending surface P which extends from the peripheries 3C and 4C of the protrusion sections 3A and 4A in the direction of the axis line O, on the protrusion sections 3A and 4A which face the protrusion direction of the protrusions 3 and 4, the individual abrasive grains 5 are supported by the protrusion sections 3A and 4A through the metal plating phase 6 at the opposite side of the protrusion direction. As shown in Fig. 5, for example, when the ends of the abrasive grains 5 located at the opposite side of the protrusion direction are laid on the protrusion sections 3A and 4A but the abrasive grains 5 are protruded from the virtual extending surface P, the protruded portions of the abrasive grains 5 are not supported by the protrusion sections 3A and 4A and thus the abrasive grains become unstable. In contrast, in the present embodiment, since all the abrasive grains 5 can be supported by the protrusion sections 3A and 4A and stably fixed to the protrusions 3 and 4, it is possible to surely prevent the abrasive grains 5 from being detached at the time of dressing and to prevent the semiconductor wafer polished by the CMP apparatus from being scratched.

Since the plurality of grains 5 is not protruded from the virtual extending surfaces P of the protrusion sections 3A and 4A, in the vicinity of the abrasive grains 5 located at the peripheries 3C and 4C, a larger space is ensured between the protrusion sections 3A and 4A and the pad which face each other, at the time of dressing, and more particularly, between the surface of the metal plating phase 6 and the pad around a portion protruded from the metal plating phase 6 of the abrasive grain 5. Accordingly, when the base 1 of the CMP conditioner rotates around the axis line O and oscillates at the time of the dressing, since the abrasive grains 5 located at the peripheries 3C and 4C in the front of the other abrasive grains 5 are closely fixed to the pad while holding a sufficient amount of the polishing fluid, it is possible to stably suppress the polishing rate of the pad for a long period, to increase the lifespan of the conditioner, and to efficiently polish the semiconductor wafer by the CMP apparatus.

In the present embodiment, since the plurality of abrasive grains 5 fixed to the protrusion sections 3A and 4A are fixed only in the region L separated from the virtual extending surface P by at least a fourth of the average grain diameter of the abrasive grain 5 and thus the non-fixture regions N to which the abrasive grains 5 are not fixed are formed at the peripheries 3C and 4C of the

protrusion sections 3A and 4A as described above, a larger space can be ensured over all circumferences in the vicinity of the abrasive grains located at the peripheries 3C and 4C in the region L. Accordingly, since the abrasive grains 5 can be closely fixed to the pad while holding the polishing fluid, it is possible to more suppress the abrasion. In the present embodiment, since the metal plating phase 6 is formed even in the non-fixture region N, it is possible to more increase fixing strength of the abrasive grains 5 of the peripheries 3C and 4C to improve stability and to more surely prevent the abrasive grains 5 from being detached.

In the present embodiment, among the plurality of abrasive grains 5 which is fixed in the region L, the abrasive grains 5 fixed to the peripheries 3C and 4C are located in the region M from the virtual extending surface P to a position separated from the virtual extending surface P by three times the average grain diameter of the abrasive grain 5, and thus, as in the case of arranging the abrasive grains 5 in a deep position of the protrusion sections 3A and 4A, the pad which is pressed and elastically deformed by the abrasive grains 5 at the time of dressing can be prevented from being brought in contact with the peripheries 3C and 4C of the protrusion sections 3A and 4A or the metal plating phase 6, and thus abrasion thereof can be prevented. Since the plurality of abrasive

grains 5 of the protrusion sections 3A and 4A presses the pad, the polishing pressure due to the press is dispersed and thus the polishing pressure can be prevented from being concentrated as in the case of the press due to a single abrasive grain to prevent the pad from being excessively cut.

As described above, when the tetrafluoride-based organic compound is coated on at least the protrusion sections 3A and 4A of the protrusions 3 and 4 in the upper surface 2 of the base 1 to which the abrasive grains 5 are fixed, the metal plating phase 6 for holding the abrasive grains 5 is suppressed from corroding even when slurry having high corrosive properties is used as the polishing fluid, because the tetrafluoride-based organic compound does not include $-CONH_2$ (amide group), $-CH_2OH$ (carbinol group), $-COOCH_8$ (nothyl ester group), -COF, -COOH, $-CC_2H$ (nothyl fluoride group), which is apt to react with chemicals having high corrosive properties, and thus has high corrosion resistance. Accordingly, the abrasive grains 5 can be prevented from being detached and thus a scratch can be prevented from being generated or the polishing rate can be prevented from being reduced. Since the tetrafluoride-based organic compound is coated, microscopic particles can be prevented from being condensed and fixed to the protrusion sections 3A and 4A of the upper surface 2 of the base 1, which are in contact with the pad,

even when, for example, ceria-based slurry having high adhesion, in which microscopic cerium oxide particles are dispersed, is used as the polishing fluid. The abrasive grains 5 are prevented from being fixed to the pad by the attached microscopic particles and thus the polishing rate can be prevented from being reduced or the attached particles can be prevented from being peeled to cause a scratch. Accordingly, stability of the polishing rate or the prevention of the scratch can be more surely accomplished.

Although, in the present embodiment, the protrusion 3 is formed in the cylindrical shape, the outer circumferential wall surface 3B thereof vertically rises from the upper surface 2 of the base 1 and vertically crosses the protrusion section 3A at the periphery 3C, the inner circumferential wall surface 4B of the protrusion 4 vertically rises from the upper surface 2 and vertically crosses the protrusion section 4A at the periphery 4C, and the extending surfaces of the wall surface 3B and 4B are identical to the virtual extending surfaces P, for example, the wall surfaces 3B and 4B may be slanted to retreat from the upper surface 2 to the protrusion sections 3A and 4A in the protrusion direction such that the sections of the protrusions 3 and 4 form trapezoidal shapes. In this case, the virtual extending surface P is a surface which extends from the cross ridge line (peripheries 3C and 4C) between

the wall surfaces 3B and 4B and the protrusion sections 3A and 4A, in the direction of the axis line O, regardless of the slanting of the wall surfaces 3B and 4B. The cross ridge lines between the protrusion sections 3A and 4A and the wall surfaces 3B and 4B may have sections having a convex curve shape such as an arc. In this case, the peripheries 3C and 4C are a tangential line portion of the cross ridge line having the convex curve shape and the flat protrusion sections 3A and 4A, and the virtual extending surface P extends from the tangential line in the direction of the axis line O. The protrusion 4 may not be the completely annular shape. For example, a slit which extends in a diameter direction of the base 1 having the circular plate shape may be formed in the protrusion 4 at an interval in the circumferential direction.

Example

Next, the effect of the example of the present invention will be demonstrated. In the present example, a pad was polished by a CMP conditioner (first example) in which a tetrafluoride-based organic compound was not coated on the upper surface 2 of the base 1 or a CMP conditioner (second example) in which a tetrafluoride-based organic compound (tetrafluoroethylene-perfluoroalkylvinyleter copolymer (PFA), molecular formula: $-(C_2F_4)_m \cdot (ROCF=CF_2)_n)$ was coated on the upper surface 2 of the base 1, according to

the above-described embodiment, and the pad polishing rate (μm/h) was measured in a predetermined period (h). As a comparative example of the first and second examples, a CMP conditioner in which a non-fixture region N of the abrasive grain 5 was not formed by the photoresist method or the template method and the abrasive grains 5 were protruded from the protrusion sections 3A and 4A was manufactured as shown in Fig. 5, a pad was polished under the same condition as the first and second examples, and the change in pad polishing rate was measured. This result is shown in Table 1.

Table 1

Lapse time	1h	2h	3h	4h	5h	6h	7h	8h	12h	15h	18h	20h	21h
First example	26.7	29.1	27.6	26.9	23.9	22.9	22.8	20.9	19.8	18.9	17.6	16.7	15.6
Second example	20.3	21.4	20.5	20.0	20.6	20.4	20.3	20.4	20.4	16.6	15.3	15.3	14.1
Comparative example	16.9	15.5	14.1	13.5	12.6	10.6	10.1	10.0	10.3	5.4	3.7	2.9	2.8

In the first and second examples and the comparative example, the outer diameter of the base 1 was 108 mm, the outer diameter of the cylindrical protrusion 3 (outer diameter of the protrusion section 3A) was 2 mm, the inner diameter of the annular protrusion 4 (inner diameter of the protrusion section 4A) was 90 mm, the outer diameter of the protrusion section 4A was 94 mm, the protrusion height of the protrusions 3 and 4 was 0.3 mm, and a substantially same number (average 35 per unit area) of abrasive grains 5 were fixed to the protrusion sections 3A and 4A. In the second example, the thickness of the coating layer using the tetrafluoride-based organic compound was about 5 μm and a portion corresponding to about 30% of the average grain diameter of the abrasive grain 5 was protruded from the coating layer.

The abrasive pad was a foamed polyurethane pad (trade name: IC1000) made by Rohm and Hass Electronic Materials, the outer diameter of the abrasive pad was 380 mm, and the above-described ceria-based slurry was used as the polishing fluid. The rotation number of the pad was 40 rpm, the rotation number of the conditioner was 40 rpm, and conditioning was performed while applying a load of 80N to the base 1 of the conditioner.

From the result of Table 1, in the CMP conditioner of the comparative example, the polishing rate was significantly reduced after one hour from start-up of

polishing of the pad and the decreasing rate of the polishing rate was significantly larger than those of the first and second examples over time. Many abrasive grains 5 which were detached from the conditioner were dispersed on the surface of the pad after one hour and most of the abrasive grains 5 protruded from the protrusion sections 3A and 4A were detached, according to the observation of the upper surface 2 of the base 1 after the polishing was finished. It was observed that the condensed cerium oxide particles were attached to the protrusion sections 3A and 4A.

In contrast, in the CMP conditioners of the first and second examples, the initial polishing rate of the first example was high upon start-up of the polishing, the decreasing rate of the polishing rate was suppressed, and a polishing rate significantly higher than that of the comparative example was maintained until the polishing was finished. According to the observation of the surface of the abrasive pad or the upper surface 2 of the base 1 after the polishing was finished, the detachment of the abrasive grains 5 was not found and the condensation and attachment of the cerium oxide particles onto the protrusion sections 3A and 4A were not found. The initial polishing rate of the first example upon start-up of the polishing was lower than that of the second example, because, in the second example, the tetrafluoride-based organic compound was

coated on the protrusion sections 3A and 4A and thus the protrusion height of the abrasive grain 5 was smaller than that of the first example.